

CLAIMS

We claim:

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- barrier layer for use in combination with a conductive layer, said barrier layer having a particular structure comprising:
- a) a first layer of TaN, having a thickness ranging from greater than about 10 Å to about 1,000 Å; and
- b) a second layer of Ta overlying said first layer and having a thickness ranging from about 5 Å to about 500 Å.
- 2. The barrier layer of Claim/1, wherein the conductive layer is copper.
- 3. The barrier layer of Claim 1, wherein said barrier layer is used in an interconnect. structure, and wherein the thickness of said TaN, layer ranges from about 50 Å to about 1,000 Å and the thickness of said Ta layer ranges from about 20 Å to about 500 Å.
- 4. The barrier layer of Claim 1, wherein said barrier layer is used in a contact via structure, and wherein the thickness of said TaN, layer ranges from about 10 Å to about 300 Å and the thickness of said Ta layer ranges from about 5 Å to about 300 Å.
- 5. The barrier layer of Claim 2, or Claim 3, or Claim 4, wherein x ranges from about 0.1 to about 1.5.



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6. A copper interconnect structure comprising the barrier layer of Claim 2 and an overlying copper layer, wherein the Cu {111} crystallographic content of said overlying copper layer is at least 70% of the Cu {111} crystallographic content which can be obtained using a pure Ta barrier layer which is about 500 Å thick.

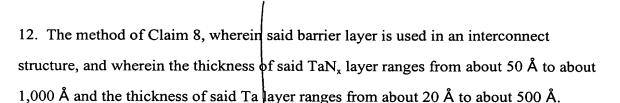
7. A copper contact via-comprising structure including the barrier layer of Claim 2 and a copper fill, wherein the copper fill layer Cu {111} crystallographic content is at least 70% of the Cu {111} crystallographic content which can be obtained using a pure Ta barrier layer which is about 250 Å thick.

8. A method of producing a barrier layer useful in combination with a conductive layer, said method comprising the steps of:

a) depositing a first layer of YaN_x having a thickness ranging from greater than about 10 Å to about 1,000 Å; and

b) depositing a second layer of Ta having a thickness ranging from about 5 Å to about 500 Å.

- 9. The method of Claim \$\%, wherein the conductive layer is copper.
- 10. The method of Claim 8, wherein said first layer of TaN_x is deposited upon a substrate having a substrate temperature ranging from about 25°C to about 500°C.
- 11. The method of Claim 8, wherein said second layer of Ta is deposited upon a substrate having a substrate temperature ranging from about 25°C to about 500°C.



- 13. The method of Claim 8, wherein said barrier layer is used in a contact via structure, and wherein the thickness of said TaN layer ranges from about 10 Å to about 300 Å and the thickness of said Ta layer ranges from about 5 Å to about 300 Å.
- 14. The method of Claim 8, or Claim 12, or Claim 13, where x ranges from about 0.1 to about 1.5.
- 15. The method of Claim 8, wherein at least a portion of said Ta layer is deposited using a traditional, standard sputtering technique.
- 16. The method of Claim 12, wherein at least a portion of said Ta layer is deposited using a traditional, standard sputtering technique.
- 17. The method of Claim 8, wherein at least a portion of the TaN_x layer is deposited using a traditional, standard sputtering technique.
 - 18. The method of Claim 8, wherein at least a portion of said Ta layer is deposited using ion-deposition sputtering.
 - 19. The method of Claim 13, wherein at least a portion of said Ta layer is deposited using ion-deposition sputtering.





20. The method of Claim 8, wherein at least a portion of the TaN_x layer is deposited using ion-deposition sputteirng.

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21. A method of producing a copper interconnect structure comprising the barrier layer of Claim 1 and an overlying copper layer, wherein the Cu {111} crystallographic content of said overlying copper layer is at least 70 % of the Cu {111} crystallographic content which can be obtained by depositing said copper layer using a pure Ta barrier layer which is about 500 Å thick, said method comprising the steps of:

- a) depositing a first layer of TaN_x having a thickness ranging from greater than about 50 Å to about 1,000 Å;
- b) depositing a second layer of Ta having a thickness ranging from about 5 Å to about 500 Å over the surface of said first layer of TaN_x; and
- c) depositing a third layer of copper over the surface of said second layer of Ta, wherein at least a portion of said third layer of copper is deposited using a physical vapor deposition technique, and wherein the substrate temperature at which said third layer of copper is deposited is less than about 500°C.
- 22. The method of Claim 21, wherein said copper interconnect structure is annealed at a temperature of less than about 500°C.





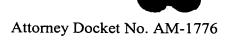
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23. A method of producing a copper-comprising contact via structure comprising the barrier layer of Claim 1 and an overlying copper layer, wherein the Cu {111} crystallographic content of said overlying copper layer is at least 70% of the Cu {111} crystallographic content which can be obtained by depositing said copper layer using a pure Ta barrier layer which is about 300 Å thick, said method comprising the steps of:

- a) depositing a first layer of TaN_x having a thickness ranging from greater than about 10 Å to about 300 Å;
- b) depositing a second layer of Ta having a thickness ranging from about 5 Å to about 300 Å over the surface of said first layer of TaN_x; and
- c) depositing a third layer of copper over the surface of said second layer of Ta, wherein at least a portion of said third layer of copper is deposited using a physical vapor deposition technique, and wherein the substrate temperature at which said third layer of copper is deposited is less than about 500°C.
- 24. The method of Claim 23, wherein said contact-comprising structure is annealed at a temperature of less than about 500°C.
- 25. The method of Claim 23, wherein said copper layer is deposited at a temperature of less than about 300°C.
- 26. The method of Claim 25, wherein said structure is annealed at a temperature of less than about 500°C.





27. A method of producing a copper-comprising contact structure including the barrier layer of Claim 1 and an overlying copper layer, wherein the Cu {111} crystallographic content of said overlying copper layer is at least 70% of the Cu {111} crystallographic content which can be obtained by depositing said copper layer using a pure Ta barrier layer which is about 300 Å thick said method comprising the steps of:

- a) depositing a first layer of TaN_x having a thickness ranging from greater than about 10 Å to about 300 Å;
- b) depositing a second layer of Ta having a thickness ranging from about 5 Å to about 300 Å over the surface of said first layer of TaN_x; and
- c) depositing a third layer of copper over the surface of said second layer of Ta, wherein at least a portion of said third layer of copper is deposited using a physical vapor deposition technique, and wherein the substrate temperature at which said third layer of copper is deposited is less than about 500°C,

wherein at least a portion of said first layer, or said second layer, or said third layer, or a combination thereof, is deposited using ion-deposition sputtering.